R E M A R K S

Claim Amendments

The amendment to claim 5 changing "surface treatment" to --surface temperature-- is consistent with the terminology set forth in claim 8.

The amendments to claim 5, 8 and 16 regarding "heat treatment conditions" and "heat treatment time" are consistent with the terminology set forth in claim 12.

Also, minor editorial revisions were made to claims 8, 12 and 16.

Rule 116

With respect of Rule 116, entry of the above amendments is respectfully requested, since such amendments involve subject matter that was set forth in the claims prior to the final rejection.

Presently Claimed Invention

Applicants' present claim 5 concerns a method of manufacturing a steel product comprising heat treating a steel product which has been subjected to quenching or accelerated

cooling on a hot rolling line after hot rolling by passing the steel product at least once through a plurality of induction heating apparatuses, which are installed on the hot rolling line, wherein a number of times of passage of the steel product through the induction heating apparatuses is such that a heat treatment time, in which a surface temperature of the steel product and a thickness-wise center temperature of the steel product are determined from the number of times of passage, a transfer speed of the steel product and an amount of electric power for the induction heating apparatuses, fall within a predetermined range, becomes the shortest,

and wherein heat treatment conditions in which the heat treatment time becomes the shortest are determined by the following steps:

(a) determining the dimensions of the steel product and a necessary temperature rise of the steel product to be subjected to the heat treating,

(b) determining the transfer speed and the amount of electric power for the induction heating apparatuses when the number of times of passage is one,

(c) determining the transfer speed and the electric power for the induction heating apparatuses when the number of times of

passage is not less than two,

(d) selecting the optimum number of times of passage in which the heat treatment time becomes the shortest, and determining the transfer speed and the amount of electric power for the induction heating apparatuses for each of the selected optimal number of times of passage.

Applicants' present claim 8 is directed to a method of manufacturing a steel product comprising heat treating a steel product which has been subjected to quenching or accelerated cooling on a hot rolling line after hot rolling by passing the steel product at least once through a plurality of induction heating apparatuses, which are installed on the hot rolling line,

wherein a number of times of passage of the steel product through the induction heating apparatus is such that a heat treatment time, in which a surface temperature and a thickness-wise center temperature of the steel product are determined based on the number of times of passage, a transfer speed of the steel product and an amount of electric power for the induction heating apparatuses fall within a predetermined temperature range within a target treatment time, and wherein heat treatment conditions in which the heat treatment time becomes within the target treatment

time are determined by the following steps:

(a) determining the dimensions and a necessary temperature rise of the steel product to be subjected to the heat treating,

(b) determining the transfer speed and the amount of electric power for the induction heating apparatuses when the number of times of passage is one,

(c) determining the transfer of speed and the amount of electric power for the induction heating apparatuses when the number of times of passage is not less than two,

(d) selecting the optimum number of times of passage, in which the heat treatment time becomes within the target treatment time, and determining the transfer speed and the amount of electric power for the induction heating apparatus for each of the selected optimum number of times of passage.

Applicants' present claim 12 relates to a method of manufacturing a steel product comprising heat treating a steel product which has been subjected to quenching or accelerated cooling on a hot rolling line after hot rolling by passing the steel product at least once through a plurality of induction heating apparatuses, which are installed on the hot rolling line, and

a surface temperature of the steel product and a temperature in a predetermined position inside the steel product are each determined as a variable based on the number of times of passage, a transfer speed of the steel product and an amount of electric power for the induction heating apparatuses,

wherein the steel product is subjected to the heat treating so that a heat treatment time, until the surface temperature of the steel product does not exceed a predetermined upper limit temperature and the temperature in a predetermined position inside the steel product reaches a target temperature, falls within a target treatment time,

and wherein heat treatment conditions in which the heat treatment time becomes within the target treatment time are determined by the following steps:

(a) determining the dimensions of the steel product and a necessary temperature rise of the steel product to be subjected to the heat treating,

(b) determining the transfer speed and the amount of electric power for the induction heating apparatus when the number of times of passage is one,

(c) determining the transfer speed and the amount of electric power for the induction heating apparatuses when the number of times of passage is not less than two,

(d) selecting an optimum number of times of passage, in which the heat treatment time becomes within the target treatment time, and determining the transfer speed and the amount of electric power for the induction heating apparatuses for each of the selected optimum number of times of passage.

Applicants' present claim 16 pertains to a method of manufacturing a steel product comprising heat treating a steel product which has been subjected to quenching or accelerated cooling on a hot rolling line after hot rolling by passing the steel product at least once through a plurality of induction heating apparatuses, which are installed on the hot rolling line,

a surface temperature of the steel product and a temperature in a predetermined position inside the steel product are each determined as a variable based on the number of times of passage, a transfer speed of the steel product and an amount of electric power of the induction heating apparatuses,

wherein the steel product is subjected to the heat treating so that a heat treatment time, until the surface temperature of

the steel product does not exceed a predetermined upper limit temperature and the temperature in a predetermined position inside the steel product reaches a target temperature, becomes the shortest,

and wherein heat treatment conditions in which the heat treatment time becomes the shortest are determined by the following steps:

(a) determining the dimension of the steel product and a necessary temperature rise of the steel product to be subjected to heat treating,

(b) determining the transfer speed and the amount of electric power when the number of times of passage is one,

(c) determining the transfer speed and the amount of electric power for the induction heating apparatuses when the number of times of passage is less than two,

(d) selecting the number of times of passage, in which the heat treatment time becomes the shortest, and determining the transfer speed and the amount of electric power for the induction heating apparatuses for each of the selected optimum number of times of passage.

Applicants' present claim 18 concerns a method of manufacturing a steel product comprising heat treating a steel product which has been subjected to quenching or accelerated cooling on a hot rolling line after hot rolling by passing the steel product three or more times through two to five induction heating apparatuses, which are installed on the hot rolling line.

Prior Art Rejections

Claim 18 was rejected under 35 USC 102 as being anticipated by or, in the alternative, under 35 USC 103 as being obvious over Hino e al. (EP 1,359230) (see the middle of page 3 of the July 7, 2008 Office Action). On page 10, lines 6 to 9 of the July 7, 2008 Office Action, the Examiner relies on WO 02/050317 for the reference date for Hino et al.

Claims 5 to 17, 19 to 20 and 22 to 29 were rejected under 35 USC 103 as being obvious over Hino et al. (EP 1359230 or WO 02/050317) for the reasons set forth on pages 3 to 9 of the July 7, 2008 Office Action.

Differences Between Applicants' Present Claims 5, 8, 12 and 16 and the Cited Reference (Hino et al. (EP 1359230))

Background

Time, speed and electric power requirements in heating treatments differ when a steel product is passed through one or more induction heating apparatuses, depending on not only the size of a steel product and the necessary magnitude of a temperature increase, but also on the number of the plurality of induction heating apparatuses and the steel plate passing time. Therefore, in conducting an actual operation, the number of times of passage, the passing speed and the electric power requirements, depending on the size of a steel product, the target temperature and so forth, are necessary to be determined.

Hino et al.

Hino et al. relate to a method of manufacturing a steel plate wherein a steel plate is discontinuously heated in two or more cycles to a target temperature, wherein the steel plate passes through a plurality of induction heating units for intermittent heating, while avoiding overheating of the surface of the steel plate.

Hino et al. differ from applicants' present claims as described as follows.

Applicants' Presently Claimed Invention
Represents a Patentable Improvement over Hino et al.

Claim 1 of Hino et al. specify that a steel plate is heated a plurality of times by an induction heating unit. Claim 8 of Hino et al. recites heating a steel plate by a plurality of induction heating units. However, Hino et al. do not teach or suggest the concrete steps of determining the number of induction heating units and the number of times the heating is to be performed.

In contrast to Hino et al., applicants' present claims 5, 8, 12 and 16 relate to a practical method for the heating of a steel plate by using induction heating apparatuses wherein the relationships between the number of induction heating apparatuses and the number of times of heating are minutely examined and determined.

In the case of heating a steel plate by using a solenoid induction heating unit, the steel plate surface is heated and a temperature induction is generated in the plate thickness direction of the steel plate. Owing to this, heating is

performed by attentively focusing on the surface temperature of the steel plate. Also, in a case wherein the steel plate temperature is high, the quantity of heat dissipated into the air is large, when compared with a case of low temperature, even if the magnitude of the temperature increase is the same, and therefore, a large amount of electric power supply is required. Applicants' present claims 5, 8, 12 and 16 address the foregoing and provide a method for determining the amount of electric power, the transfer speed, the number of times of passage and the number of induction heating apparatuses.

Hino et al., on pages 3 to 4 in paragraph Nos. [0020] to [0022], disclose a method for determining the amount of electric power to an induction heating unit according to the following equation (1) when the necessary temperature increased is provided, so as to rapidly carry out tempering at or shorter than the rolling pitch:

$$P \geqq (1/\eta)\cdot\rho\cdot H\cdot W\cdot L\cdot Cp\cdot(\Delta T/\Delta t)\cdot[(Lc+Lw)/Lc]\cdot[1/(N\cdot M)] \quad \ldots\ldots\ldots\ldots (1)$$

, wherein P: whole electric power, η: heating efficiency, ρ: density, H: plate thickness, W: plate width, L: plate length, Cp: specific heat, ΔT: temperature increase, Δt: rolling pitch, Lc: coil length, Lw: distance between induction heating units, N:

number of induction heating units, and M: number of times of heating.

Nevertheless, the above-mentioned equation (1) was formulated to be used at the time of designing heat treatment equipment using induction heating apparatuses for determining the number of induction heating apparatuses and their electric power capacity when the magnitude of the temperature increase is given. This is different from the methods of applicants' present claims 5, 8, 12 and 16, which are to be used in actual heating operations.

The preceding paragraph is explained in detail as follows:

1. <u>There is no description of the traveling speed in the Equation (1) of Hino et al.</u>

Electric power for heating should be determined in proportion to the traveling speed of a steel plate. Nonetheless, this is not expressed in the equation (1) of Hino et al., although the rolling pitch is indicated as a parameter. In contrast thereto, if the traveling speed at every heating time is changed in applicants' present claims 5, 8, 12 and 16, heating can be performed in a shorter time with a smaller electric power supply. This is not possible in the equation (1) of Hino et al.,

because the traveling speed at every heating time is not obtained.

On the other hand, as shown in applicants' Table 1 with Examples of the size of steel plates and the traveling speed, according to applicants' claims 5, 8, 12 and 16, the traveling speeds are altered at every heating time.

2. Hino et al. Do Not Disclose a Parameter Temperature in Their Equation (1)

With a solenoid type induction heating apparatus, the steel plate surface is heated by the skin effect of the induced electric current. This is a hindrance to the implementation of heat treatment for heating a steel plate up to a target temperature by using induction heating apparatuses.

This fact is not expressed in the equation (1) of Hino et al.

3. In Equation (1) of Hino et al., Both the Shortest Heating Time and the Minimum Consumption Rate of Electric Power Are Not Expressed

The amount of heat dissipated in the air differs by the temperature of a steel plate. Therefore, the electric power for heating and traveling speeds vary by the temperature of the steel

plate, even when the magnitude of the temperature increase is the same. In view of this, the combination of the amount of electric power, the number of heating times of passage, and the traveling speed differ between the cases of a minimum heating time and a minimum consumption rate of electric power. This phenomenon is not taken into account in the equation (1) of Hino et al.

On the other hand, with applicants' present claims 5, 8, 12 and 16, the relationships among the amount of electric power, the number of times of passage and the traveling speed are taken into account. As examples, there are shown in applicants' Fig. 4, the number of times of passage with priority in treatment time, while the number of times of passage with priority in electric power consumption rate is depicted in applicants' Fig. 5.

For example, as set forth in the present specification from page 18 at line 19 to page 23 at line 16, under the heading "Sixth embodiment" and in applicants' Fig. 3A to Fig. 3C and Figs. 4 and 5, it is understood from the results therein that the length of the heat treatment time can be shortened and the electric power consumption can be reduced when heating is performed by passing 3 times through 3 units of induction heating apparatuses, while controlling the speed at every time of passage

rather than passing time through 6 units of induction heating apparatuses or passing 1 time through 3 induction heating apparatuses. Moreover, when the number of units of induction heating apparatuses is reduced, the amount of capital investment is reduced.

In applicants' Fig. 4 and Fig. 5, there is shown an advantageous number of times of passage in terms of time and the amount of electric power supply depending on the thickness of the steel sheet, the length of the heating time and the target of the heating. When the thickness of a steel plate is large, the length of treatment time is reduced by passing the plate a plurality of times. However, there are cases when heating one time is advantageous if the thickness of a steel plate is small.

As discussed above, applicants' present claims 5, 8, 12 and 16 provide a method of determining what passing time is most appropriate by selecting the length of the heating time and the electric power to be consumed, after obtaining the speed and the electric power supply at every number of times of passage. This is not taught or suggested by Hino et al.

Further, Hino et al. do not teach or suggest the "Third embodiment" set forth from page 11 at line 11 to page 17 at line 17 in applicants' specification, wherein the necessary conditions of applicants' present claims 5, 8, 12 and 16 are set forth (see page 31, line 6 to page 37, line 12 of applicants' specification) and applicants' Figs. 11 to 13. Methods are described therein for (i) heating a steel plate in the shortest period of time; (ii) heating a steel plate, within a targeted time or (iii) heating a steel plate while reducing the electric power consumption to a minimum.

Applicants' claims 5, 8, 12 and 16 provide an improvement over Hino et al. in that simultaneously a high productivity and a reduction of electric power consumption are realized by applicants' claimed methods.

For the reasons discussed above, applicants' present claims 5, 8, 12 and 16 solve the problems occurring at the time of actually conducting heating of a steel plate, which cannot be accomplished by Hino et al.

Applicants' present claims provide methods of determining speed and electric power at every passage and selecting the most suitable passing time based on the heat treatment time and

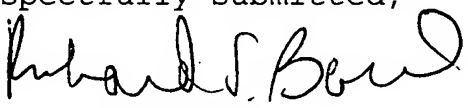
electric power consumption. Such methods are not taught or suggested by Hino et al.

Withdrawal of each of the prior art rejections is thus respectfully requested.

Reconsideration is requested. Allowance is solicited.

If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the undersigned at the number given below for prompt action.

Respectfully submitted,



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Enc.: PETITION FOR EXTENSION OF TIME